# BIMONTHLY SUMMARY

## September - October 2001

## Personnel

Carol Heller retired in early September after nineteen years of outstanding telescope operation. We will all miss Carol's steady hand at the tiller of the telescope as well as her unparalleled experience and delightful personality.

Former MMTO employee Karl Harrar was hired as a consultant in early September to assist with preparations to realuminize the primary mirror.

UA undergrad Josh Ludeke was hired in October as an engineering aide.

Craig Foltz and Dan Brocious attended the Pima County Board of Supervisors meeting on October 16. The Board unanimously approved the draft Pima County Outdoor Lighting Code. Although the restrictions on outdoor lighting were relaxed from earlier versions of the draft code, this is a major victory for proponents of sensible lighting and astronomy in Southern Arizona. A copy of the code can be found at *http://sculptor.as.arizona.edu/foltz/ POLC*

Craig Foltz gave an invited talk on the MMT Conversion at the SPIE "Optics Southwest 2001" meeting in Tucson on September 17.

The MMT Council met in Cambridge on September 5. Steve West attended the meeting along with Craig Foltz.

## Development

### Aluminizing

Although much of the following information belongs in the next Bi-Monthly Summary, we cannot contain our excitement about the aluminization.

"Ninety-one percent reflectance" summarizes it all. Results of several months' hard work of teams led by B. Kindred and D. Clark were realized in early November when the 6.5m mirror was successfully coated in the telescope (in-situ method). September and October activities included: rework of the power modules that supply up to 16,000 amps of battery current to 200 filamentheated aluminum sources; installation of new electrical bus-bars, filament supports, and baffles in the "portable" 7 meter vacuum head; assembly of vacuum pumps and piping; and sealing heavy covers to convert the telescope into a complete vacuum chamber.

In less than one minute, 93 nm (thickness) of pure aluminum was vapor deposited onto the 21.5 ft. diameter surface. The coating is very uniform with near "textbook" reflectance at 450 nm of 91%! Details follow.

On Friday November 9 the MMT 6.5m primary mirror was coated successfully for the first time. Excepting pressure, all parameters were well within limits. There was an irreparable perforation in the pressure membrane (as yet unexplained but likely in the central hole) which limited chamber pressure to 2.0 X $10^{-5}$ Torr, a decade higher than we would have liked, but we knew from previous experience that acceptable films could be produced at this pressure. In addition, the new cryopump exhibited behavior that rendered its effectiveness highly questionable. The second stage temperatures came down much more quickly than they should have and all stopped exactly at 10K – behavior you might expect from heads that are not attached to any load or thermal mass. There was a handling mishap that possibly could have caused this kind of condition. We proceeded on the assumption that, at the very least, it was a huge Meissner trap that would aggressively pump water vapor, the major gas/vapor constituent at our working pressures. In the face of these exceptions the shot went perfectly. The $H_2$ surge peaked at 2.5 X $10^{-5}$ Torr and pressure quickly returned to baseline – evidence of 1) low gas evolution and 2) very high light-gas pumping speed. 930Å were deposited at an average evaporation rate ≈50Å/s; peak power module duty cycle was 60%. Filaments wetted uniformly and had considerable load remaining after the shot. Reflectance measured at 4500Å with the MMT reflectometer, and Gary Poczulp's Minolta CM-2002 spectrophotometer was 91.0%, slightly below perfection.

These improved numbers result from two fundamental changes to the system:

1) Nothing in the belljar now undergoes heating except the tungsten filaments and aluminum loads – previously a great deal of copper conductor and insulating ceramic was brought to elevated temperature, liberating unmanageable quantities of gas.
2) The rods previously used necessitated a series power scheme that proved unworkable. Conventional filaments are now powered in parallel.

Details of the new power system follow:

The original K. Harrar controller for the power module control in the aluminizing system was completely disassembled and rebuilt using a "card cage" packaging approach. This allowed for much easier access for checkout, troubleshooting, and repair. New wire-wrap boards were built by C. Knop and B. Comisso for the system, along with an all-new power supply subsystem and cables. A new control box, for use by the aluminizing "pilot" (i.e., J.T. Williams) during the shot, was also built that allowed for immediate feedback of the power level being delivered to the system on all of the ten circuits. The system performed flawlessly during extensive checkout and "preflight" prior to the shot; no problems were experienced during deposition.

Testing started with the incorporation of the controller chassis (built by D. Clark, C. Knop, and B. Comisso) into the aluminizing system. Also during this test period extensive data were accumulated on module performance under simulated load conditions. The basic mirror aluminizing system consists of a belljar with electrical feedthroughs with bypass capacitors that connect to tungsten heater elements inside the belljar vacuum chamber. A test setup simulated the belljar electrical configuration by modeling the belljar feedthrough with a capacitor/cable connection point consisting of two capacitors (50,000 uF at 80 Volts) connected to the PWM power modules by three 20 ft. 2/0 cables (high side drive, low side drive, and neutral). Then from the capacitors were added three 16 ft. 2/0 cables to a center tapped 6 milliohm load resistor – the center connected to neutral and the end taps connected to the high side drive and low side drive cables to simulate the tungsten elements. Testing in this manner allowed the discovery and testing of needed system modifications for improved performance and reliability. Since high switching transients on the power FETs will destroy them, the first modifications concentrated on reducing the di/dt switching transients of the system by two methods: 1) modifying the existing resistor/capacitor snubber network and 2) increasing the FET gate turn-on time. Optimization of these parameters was mainly achieved by testing various component values and configurations. Increasing the gate resistance and repositioning a gate diode, along with decreasing the snubber resistance, reduced transients significantly. Other techniques used to reduce transients were careful attention to battery/ module interconnection type and length; that is, using flat rectangular solid/weaved copper conductors in place of round cables. Also, transient suppression diodes were added at the belljar feedthrough connections.

This testing phase also brought up the issue of proper module cooling. This important consideration was addressed by increasing the snubber diode and load diode heat sinking areas and by improving air circulation with fans. The most significant improvement was the K. Van Horn/J.T. Williams idea of placing the modules in a tub of water.

Finally, during testing it was determined that the belljar bypass capacitors are not required for good system performance. They would consistently fail even when replaced with higher voltage rating types, so the capacitors were removed from the system.

In spite of the system's performance, it is now clear, however, that the old power modules have severe performance limitations, and due to the unavailability of replacement MOSFETs for switching the high aluminizing currents, a new power module design is being investigated using commercially-available IGBTs with considerably higher voltage stress ratings than the original design. The new design will eliminate the water-filled cooling tubs used for the last shot in favor of chilled-liquid cold plates mounted on top of forced-air cooled fin assemblies. It is expected that this setup can be tested on a small scale by spring 2002.

**Mirror Support**

S. Callahan and J.T. Williams designed a modification to "tran torque" devices that attach the single-axis actuators to the telescope loadspreaders. This part will be fabricated at Prototech Industries in time for installation of the actuators after aluminization. The actuator rebuilding was completed. This has now eliminated the leaks in the pneumatic cylinders that limited our ability to raise the mirror at low temperatures.

Following their rebuilding, all of the primary support actuators were recalibrated. The calibration data was reduced, validated, and entered into tables in the support system software. At this time, a slightly more sophisticated model for handling the actuator calibration data was introduced into the primary cell software (with great care, since changes must be tested on the actual glass mirror rather than the steel dummy mirror previously available to test such changes.)

**Top End**

S. Callahan and R. Ortiz removed the secondary spiders and fixed hub for a variety of modifications in order to improve the secondary resonant frequencies, secondary alignment, and cabling access.

**Thermal System**

D. Gibson added new functionality to the thermal system software to communicate with the Carrier chiller via a serial connection. This functionality will allow the cooling setpoint for the chiller to be set automatically, based upon ambient temperature or mirror temperature, or set manually by the operator. Related data, such as the leaving water temperature for the chiller, are available to the TCS and telescope operator through a user interface. New PID control loop parameters that include automated modification of the Carrier and Neslab setpoints will be determined when the telescope and support systems are reassembled following aluminization.

**F/9-F/15 Hexapod**

Existing hexapod software was substantially rewritten by D. Gibson to: 1) simplify the user interface for the telescope operators, 2) redesign the user interface so that it has a similar "look-and-feel" to other MMT software, 3) divide server and client software functionality into separate programs, 4) implement the SAO "msg" messaging protocol between client and server as is being used in other MMT software, and 5) serve as a basis for software development for future secondary units. Included in this software work was migration of the SAO msg messaging software into VxWorks for the real-time hexapod VME computer. Modification was made to the user interface to communicate directly via msg with the VME crate, rather than through an intermediate program written in Tcl. C code was also written for hexapod calibration and coordinate transformation. These functions had been located in the Tcl-based user interface.

**F/9 Secondary**

A new system for measuring the mirror displacement relative to the cell was implemented using a Mitutoyo Mu-checker. It can measure very small mirror movement with little effect due to varying gravity. It is capable of measuring motion equivalent to 10nm of coma. It will be essential for diagnosing and repairing the past problems with the secondary as well as for the modifications to the tangent and axial hardpoints.

R. James and C. Wainwright redesigned the flexures for the f/9 tangent rods and axial hardpoints. This design will be fabricated at Southwest EDM.

The f9 secondary has been rewired and checked out.

**F/9 Top Box Shack-Hartmann Wavefront Sensor**

To expedite the completion of the device without impacting other ongoing mechanical activities, we will use Newport's standard X-26 rail system. All of the optical components and X-26 parts have been ordered.

**F/5 Secondary and Hexapod**

During September C. Wainwright designed and detailed the fabrication drawings of the f/5 dummy mirror. This steel mirror will be installed to test the servo/support system before installation of the glass mirror.

S. Bauman and S. Callahan designed the interface of the f/5 cell to the fixed hub. This required design drawings for an assembly of drawings for fabrication in the University Research Instrumentation Center.

The f/5 hexapod control design underwent some major cable redesign to better accommodate the plan to use the top side of the spider arms to provide cable runs to the secondary hub. New flat cable for this purpose is now in hand for final construction and use.

The f/5 control hardware is nearly complete. We await final design tweaks and checkout in early 2002.

J. Ludeke and S. Callahan designed the teststand for the f/5 support system. This stand will allow testing at various elevation angles and will also support the cell when it is off the telescope.

**F/15 Secondary**

S. Callahan and R. James purchased an engine stand and heavily modified it for hexapod installation to the f/9 and f/5 cells.

C. Wainwright worked with S. Callahan and M. Rascon (CAAO) on the rail system for installing the f/15 secondary and the optics that reside in the fixed hub. C. Wainwright detailed all drawings for fabrication.

## Computers and Software

Up to this time, we have done our development of VxWorks based control software on Sun/Solaris computers, but we now have brought on-line a well tested Linux-based development system for our many VxWorks projects. This allows us to use much faster Intel based Linux machines, and moves us closer to being able to decommission our old Sun machines. The msg communication protocol was ported to run within VxWorks, and a preliminary version tested with the f/9 hexapod control software.

Related to the migration of the msg messaging protocol into VxWorks, a new Python package, PyMsg, was developed from the C version of the msg protocol. This new package will allow Python, a powerful, object-oriented scripting language, to be used to communicate directly with msg-based applications on the telescope computer system (TCS).

The user interface for the cell VME computer is currently written in WindX. This requires a remote display of the WindX display from the cell VME crate onto the operator's computer. The result is a sluggish response of the user interface. A new user interface was implemented using Tcl/Tk, similar to other user interfaces currently used in the TCS. Work will continue on migration of the cell system user interface from the VME crate into a Tk-based user interface.

Work was initiated on replacing a number of serial cables and connections with network socket connections through a Cyclades terminal server. When in place, this terminal server will eliminate several serial cables that connect support systems, such as the Neslab and Carrier chillers, to the control room and will reduce the threat of hardware damage due to lightning.

With the telescope offline during the aluminization effort, this was an excellent opportunity to update operating system software on the mountain computers. The computers running Linux were upgraded to Red Hat 7.2, and a few issues that this brought up were addressed (one device driver needed to be reworked to run with the 2.4 Linux kernel). This is of particular value for the security enhancements it offers.

We moved the traffic for the MMT mountain network from the old pair of T1 links onto the new OC-3 ATM radio link. This increases our bandwidth from the 3 megabits we previously shared with the IOTA project to a present 10 megabit capacity. This will increase again to 100 megabits (shared in part with the Ridge) when we deploy a short new fiber link between the communications building and the MMT building proper. The changeover will also allow us to eventually put all downtown and mountain machines on the same network, which will simplify network management, especially for Windows machines.

T. Pickering took the old version of the DT3155 framegrabber linux device driver and updated it to work with the newest linux kernel versions. This allowed him to upgrade machines with DT3155 cards to the latest operating system versions and to do further development on the driver and tools that use it, such as the SAO guider system. The new version also seems to fix the random stability problems that had plagued the older driver.

T. Pickering developed a new application, gleaky, which takes advantage of the DT3155 driver. He developed/updated and provided an easy-to-use GUI to display video feeds on the mountain computers. It implements the "leaky" algorithm to integrate the incoming video images in real-time to improve sensitivity to faint sources. It will replace the old electronic 'Wagner' box that was previously used to integrate video signals from the acquisition/guide cameras. It also replaces the very rudimentary existing video display GUI that the telescope operators found hard to use and not very reliable. Gleaky runs on any linux desktop with no problem and is started by simply clicking on an entry in the main system menu.

T. Pickering and T. Trebisky traveled to Boston to visit with the CfA software people to discuss the status and future of the SAO guider system. Many changes and simplifications were agreed upon, including a much easier interface for configuring the guider to handle different instruments. B. McLeod and J. Roll are doing the work to rework the guider code. When they finish, T. Pickering will take the final product and get it working on our mountain machines with the site instrumentation.

T. Pickering obtained and configured a new computer that will eventually replace nemo as the main server machine for the MMT. The first step in the process, automatically backing up the MMT's various Windows machines every night, was successfully implemented.

Observer preparation forms and confidential observer reports are now available on-line. Observers will be directed to them when observing resumes.

## Optics

No activity to report.

## General Facility

Thanks to an enormous amount of effort by the FLWO Support Crew and Karen Myres, the MMT now has a new kitchen. The old kitchen was gutted and the room received new wallboard, a new suspended ceiling, and vinyl flooring. New cabinets and appliances were purchased along with a new table and chairs. The layout of the new kitchen is far more efficient and spacious. Among the features we now enjoy are filtered water via a reverse osmosis system, an icemaker, a trash compactor that works reliably, a huge new refrigerator, and a jumbo galley sink. We have far more cabinet and counter space. A huge 'thank you' goes out to all who were involved with the project. Some of the funds for the renovation came from a grant from the Roger Firestone Foundation.

Modifications to room 303 interior began in preparation for the Hectospec and Hectochelle optical tables. R. Hutchins (FLWO) is leading this effort.

## Maintenance and Repair

The Carrier interface module is installed and functional. D. Gibson has checked it out. The cabling is run but not yet connected to the drive room.

## Visitors

October 12: Dr. Bobby Ulich (former MMTO engineer, now with Kaman Aerospace Corp.) and several colleagues, accompanied by Warren Davison (Steward). Together with Steward Observatory they are building Lotus, a 6.5m collimator for Lockheed Martin Space Systems Company.

## Publications

### MMTO Internal Technical Memoranda

None

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None

**MMTO Technical Reports**

None

**Scientific Publications**

01-16 Subarcsecond Mid-Infrared Structure of the Dust Shell Around IRAS 22272+5435
Ueta, T., Meixner, M., Hinz, P. M., Hoffmann, W. F., Brander, W., Dayal, A., Deutsch, L. K., Fazio, G. G., Hora, J. L.
*ApJ*, **557**, 831

01-17 Detection of Superhumps in XTE J1118+48 Approaching Quiescence
Zurita, C., Casares, J., Shahbaz, T., Wagner, R. M., Foltz, C. B., Rodríguez-Gil, P., Hynes, R. I., Charles, P. A., Starrfield, S. G.
Accepted by *MNRAS*

01-18 Simultaneous Photometry and Spectroscopy of the Supersoft X-Ray Source RX J0019.8+2156 (QR Andromedae)
McGrath, T. K., Schmidtke, P. C., Cowley, A. P., Ponder, A. L., Wagner, R. M.
*AJ*, **122**, 1578

01-19 The Metallicity of the Redshift 4.16 Quasar BR2248-1242
Warner, C., Hamann, F., Shields, J. C., Constantin, A., Foltz, C. B., Chaffee, F. H.
Accepted by *ApJ*

01-20 A Search for Signatures of Quasar Evolution: Comparison of the Shapes of the Rest-Frame Optical/Ultraviolet Continua of Quasars at $z>3$ and $z\sim0.1$
Kuhn, O., Elvis, M., Bechtold, J., Elston, R.
*ApJ*, **136**, 225

01-21 Constraints on Disk Sizes around Young Intermediate-Mass Stars: Nulling Interferometric Observations of Herbig Ae Objects
Hinz, P. M., Hoffmann, W. F., Hora, J. L.
*ApJ*, **561**, L131

**Observing Reports**

Copies of these publications are available from the MMTO office. We remind MMT observers to submit observers' reports, as well as preprints of publications based on MMT research, to the MMTO office. Such publications should have the standard MMTO credit line: "Observations reported here were obtained at the MMT Observatory, a facility operated jointly by the Smithsonian Institution and the University of Arizona."

Submit publication preprints to *bruss@as.arizona.edu* or to the following address:

MMT Observatory
P.O. Box 210065
University of Arizona

Tucson, AZ 85721-0065

**MMTO in the Media**

A color photo of the MMT by Howard Lester graces the cover of the fall 2001 issue of the Arizona Alumnus magazine. The photo headlines the MMT article within.

**MMTO Home Page**

The MMTO maintains a World Wide Web site (the MMT Home Page) which includes a diverse set of information about the MMT and its use. Documents that are linked include:

1. General information about the MMT and Mt. Hopkins.

2. Telescope schedule.

3. User documentation, including instrument manuals, detector specifications, and observer's almanac.

4. A photo gallery of the Conversion Project as well as specifications and mechanical drawings related to the Conversion.

5. Information for visiting astronomers, including maps to the site and observing time request forms.

6. The MMTO staff directory.

The page can be accessed in two ways. First, it can be loaded via URL *http://mmt.as.arizona.edu*. Second, it can be accessed via a link from the OIR's MMT page at URL *http://cfa-www/cfa/oir/MMT/mmt/foltz/mmt.html.*